Method of Test for
DETERMINATION OF MOISTURE CONTENT
DOTD Designation: TR 403-02

Method A – Rapid Drying

I. Scope

This procedure is designed to determine the moisture content of treated or untreated soil, aggregates, or soil-aggregate mixtures by drying the material on a hot plate.

II. Apparatus

A. **Scales**
   2. 20 lb or greater capacity, sensitive to 0.01 lb.
   3. 10 kg capacity, sensitivity to 1 g.
   4. 1 kg or greater capacity, sensitive to 0.1 g.

B. Electric or gas hot plate – an open flame hot plate shall be equipped with a suitable shield to disperse heat evenly and to prevent direct contact of the flame with the drying pan.

C. Pans – sufficient to hold sample without spilling and large enough to spread the material for rapid drying.

D. Brush

E. Stirrer – spoon or spatula

F. Thermal gloves, apron, tools, eye protection – for handling hot materials

III. Sample

The entire sample may be used to determine moisture content. If a representative portion is used, obtain the representative portion in accordance with DOTD TR 108 or in accordance with the instructions of the applicable procedure.

The following minimum sizes will apply.

A. Soils – 500 g
B. Aggregates – 10 lb
C. Soil-Aggregate Mixtures – 5 lb

IV. Health Precautions

Proper equipment and precautions are to be taken whenever hot materials or equipment must be handled. Use container holders or gloves while handling hot containers. Wear eye protection while stirring and weighing the heated material due to possible shattering of particles. Highly organic soils and contaminated materials may ignite during drying. Provide a means of smothering the flames to prevent personal injury. Drying contaminated materials may create toxic fumes. Dry contaminated materials under a vent to prevent exposure to possible fumes.

V. Procedure

A. Place wet material in a drying pan of known tare weight. Weigh and record the weight of the wet material and pan to the nearest 0.01 lb, 1 g or 0.1 g, depending on the sensitivity of the scale.
B. Place pan containing wet material on the hot plate and heat, stirring constantly to accelerate drying and to avoid localized overheating.
C. Do not lose any particles from spillage or adherence to the stirrer. Brush material adhering to stirrer into pan. Control heat to avoid loss of material from exploding particles. Dry to a constant weight.

Note A-1: *Constant weight for drying purposes is defined as less than 0.1% weight loss between successive weighings no less than 5 minutes apart.*

D. Cool the pan and dried material just until the pan can be handled without gloves. Weigh the pan with the material and record.

VI. Calculations

A. Subtract the tare weight of the pan from the weight of dried material and pan to determine the weight of the dried material and record.
B. Determine the weight of water in the material by subtracting the weight of the dried material and pan from the weight of the wet material and pan and record.
C. Calculate the moisture content, %, (MC) to the nearest 0.1% using the following formula:

$$MC = \frac{W \times 100}{D}$$

where:

W = weight of water, lb or g
D = dry wt of material, lb or g
100 = constant

example:

W = 35.0 g
D = 488.0 g
100 = constant

$$MC = \frac{35.0 \times 100}{488.0}$$

$$MC = \frac{3500}{488.0}$$

$$MC = 7.172$$
$$MC = 7.2\%$$

D. When a representative portion is used to determine the moisture content and the total dry weight of the sample is required, calculate the total dry weight (TDW) to the nearest 0.01 lb or 1 g using the following formula:

$$TDW = \frac{TWW \times 100}{100 + MC}$$

where:

TWW = total wet weight, lb or g
MC = moisture content, %
100 = constant

example:

TWW = 25.00 lb
MC = 7.2%
100 = constant

$$TDW = \frac{25.00 \times 100}{100 + 7.2}$$

$$TDW = \frac{2500}{107.2}$$

$$TDW = 23.3208$$
$$TDW = 23.32\,lb$$

VII. Report

A. Report the percent moisture to the nearest 0.1%.
B. When the total dry weight of sample is calculated, report the total dry weight to the nearest 0.01 lb or 1 g.

VIII. Normal Test Reporting Time

Normal test reporting time is one hour.

DOTD Designation: TR 403-02

Method B – Oven Drying

I. Scope

This procedure is designed to determine the moisture content of treated or untreated soil, aggregates, or soil-aggregate mixtures by drying the material in an oven.

II. Apparatus

A. Scales
1. 20 lb or greater capacity, sensitive 50 0.01 lb.
2. 10 kg capacity, sensitive to 1 g.
3. 1 kg or greater capacity, sensitive to 0.1 g.

B. Oven – approved thermostatically controlled, ventilated oven capable of maintaining a temperature of 230±9°F (110±5°C).

C. Pans – sufficient to hold sample without spilling and large enough to spread the material for rapid drying.

D. Thermal gloves, apron, tools, eye protection – for handling hot materials.

III. Sample

The entire sample may be used to determine moisture content. If a representative portion is used, obtain the representative portion in accordance with DOTD TR 108 or in accordance with the instructions of the applicable procedure.

The following minimum sizes will apply.

A. Soils – 500 g
B. Aggregates – 10 lb.
C. Soil-Aggregate Mixtures – 5 lb.

IV. Health Precautions

Proper equipment and precautions are to be taken whenever hot materials or equipment must be handled. Use container holders or gloves while handling hot containers. Wear eye protection while stirring and weighing the heated material due to possible shattering of particles. Highly organic soils and contaminated materials may ignite during drying. Provide a means of smothering the flames to prevent personal injury. Drying contaminated materials may create toxic fumes. If the oven is not vented, provide adequate ventilation for the room.

V. Procedure

A. Place wet material in a drying pan of known tare weight. Weigh and record the weight of the wet material and pan to the nearest 0.01 lb, 1 g, or 0.1 g depending on the sensitivity of the scale.
B. Place pan containing wet material in the oven at 230±9°F (110±5°C) and dry to a constant weight.

Note B-1: *Constant weight for drying purposes is defined as less than 0.1% weight loss between successive weighings no less than 5 minutes apart.*

C. Cool the pan and dried material just until the pan can be handled without gloves. Weigh the pan with the material and record.

VI. Calculations

A. Subtract the tare weight of the pan from the weight of dried material and pan to determine the weight of the dried material and record.
B. Determine the weight of water in the material by subtracting the weight of the dried material and pan from the weight of the wet material and pan and record.
C. Calculate the moisture content, %, (MC) to the nearest 0.1% using the

following formula:

$$MC = \frac{W \times 100}{D}$$

where:

W = weight of water, lb or g
D = dry wt of material, lb or g
100 = constant

example:

W = 35.0 g
D = 488.0 g
100 = constant

$$MC = \frac{35.0 \times 100}{488.0}$$

$$MC = \frac{3500}{488.0}$$

$$MC = 7.172$$
$$MC = 7.2\%$$

D. When a representative portion is used to determine the moisture content, and the total dry weight of the sample is required, calculate the total dry weight (TDW) to the nearest 0.01 lb or 1 g using the following formula:

$$TDW = \frac{TWW \times 100}{100 + MC}$$

where:

TWW = total wet weight, lb or g
MC = moisture content, %
100 = constant

example:

TWW = 25.00 lb
MC = 7.2%
100 = constant

$$TDW = \frac{25.00 \times 100}{100 + 7.2}$$

$$TDW = \frac{2500}{107.2}$$

$$TDW = 23.3208$$
$$TDW = 23.32\,lb$$

VIII. Report

A. Report the percent moisture to the nearest 0.1%.
B. When the total dry weight of sample is calculated, report the total dry weight to the nearest 0.01 lb or 1 g.

VIII. Normal Test Reporting Time

Normal test reporting time is 24 hours.

DOTD Designation: TR 403-02

Method C – Rapid Drying with Microwave Oven

I. Scope

A. This procedure is designed to determine the moisture content of treated or untreated soils (containing less than 5% aggregate retained on a No. 4 sieve) by drying the material in a microwave oven equipped with an inverter.

B. Disallowed Materials – materials containing gypsum (blended calcium sulfate), iron ore, and treated or untreated soils containing 5% or more aggregate retained on a No. 4 sieve.

C. Reference Document
DOTD TR 108 – Splitting and Quartering Samples

II. Apparatus

A. Electronic Scales – 1 kg or greater capacity, sensitive to 0.1 g.

B. Microwave Oven – a 700 watt microwave oven with an inverter. The inverter is a device which allows the actual power output to be adjusted.

C. Containers – shall be microwave safe and capable of withstanding the heat generated by the test specimen without deformation. Containers made of purex are ideal.

D. Fire Brick

E. Safety Equipment – thermal gloves, apron, tools, eye protection, hot pad, fire extinguisher, and vent hood.

F. Container Cover – a microwave safe cover with small holes punched through it to allow the moisture to escape during the drying process.

III. Sample

Obtain a sample size from 500 to 1000 grams for all materials. For larger samples, obtain a representative portion in accordance with DOTD TR 108 or in accordance with the instructions of the applicable procedure.

IV. Health Precautions

Proper equipment and precautions are to be taken whenever hot materials or equipment must be handled. Use container holders or gloves while handling hot containers. Wear eye protection while stirring and weighing the heated material due to possible shattering of particles. Highly organic soils and contaminated materials may ignite during drying. A means of smothering the flames such as a fire extinguisher must be o hand to prevent personal injury. Drying contaminated materials may create toxic fumes. Dry all materials under a vent to prevent exposure to possible fumes.

V. Procedure

A. Using TR 108, obtain a 2000 g representative portion and place in a waterproof container.

B. Obtain a test specimen from the representative portion. Its weight should be between 500 and 1000 g.

C. Place the wet material in a microwave safe container of known tare weight.

D. Place and insulating material such as cardboard on the scale platform. Weigh and record the weight of the wet material and container to the nearest 0.1 g.

E. Place the brick in the oven.

F. Place the container of wet material into the microwave oven.

G. Dry the test specimen at a power setting equivalent to 700 watts (see Step VI.B) for a duration of **six minutes**.

H. Remove the test specimen from the microwave oven and weigh.

I. Readjust the microwave oven's power setting to obtain 700 watts, and dry for a duration of **one minute**.

J. Remove the test specimen from the microwave oven and weigh. Continue drying the test specimen at 700 watts and one minute durations until constant weight is obtained.

Note C-1: *Constant weight for drying purposes is defined as less than 0.1% weight loss between successive weighings no less than 5 minutes apart.*

K. If any material is lost due to spillage or aggregate explosions, then the test is considered invalid. Obtain a new test specimen and repeat Steps B – J. Place the new specimen in a microwave safe container with a microwave safe cover.

VI. Calculations

A. **Moisture Content**

1. Subtract the tare weight of the container from the weight of dried material and container to determine the weight of the dried material and record.
2. Determine the weight of water in the material by subtracting the weight of the dried material and container from the weight of the wet material and container and record.
3. Calculate the moisture content, %, (MC) to the nearest 0.1% using the following formula:

$$MC = \frac{W \times 100}{D}$$

where:

W = weight of water, lb or g
D = dry wt of material, lb or g
100 = constant

example:

W = 35.0 g
D = 488.0 g
100 = constant

$$MC = \frac{35.0 \times 100}{488.0}$$

$$MC = \frac{3500}{488.0}$$

$$MC = 7.172$$

$$MC = 7.2\%$$

4. When a representative portion is used to determine the moisture content and the total dry weight of the sample is required, calculate the total dry weight (TDW) to the nearest 0.1 g using the following formula:

$$TDW = \frac{TWW \times 100}{100 + MC}$$

where:

TWW = total wet weight, g
MC = moisture content, %
100 = constant

example:

TWW = 6000.0 g
MC = 7.2%
100 = constant

$$TDW = \frac{6000.00 \times 100}{100 + 7.2}$$

$$TDW = 5{,}597.015$$

$$TDW = 5{,}597.0\ g$$

B. Microwave Oven Power Settings

1. Obtain the maximum output rating for the microwave oven.

2. Calculate the power-setting (PS) to be used for drying test specimens.

$$PS = \frac{700 \times n}{OP}$$

where:

OP = maximum output power, watts
700 = drying output power, watts
n = full range of microwave setting

example:

OP = 1,100 watts
n = 10

$$PS = \frac{700 \times 10}{1{,}100}$$

$$PS = 6.36$$

$$PS = 6$$

VII. Report

A. Report the percent moisture to the nearest 0.1%.
B. When the total dry weight of sample is calculated, report the total dry weight to the nearest 0.1 g.

VIII. Normal Test Reporting Time

Normal test reporting time is 45 minutes.